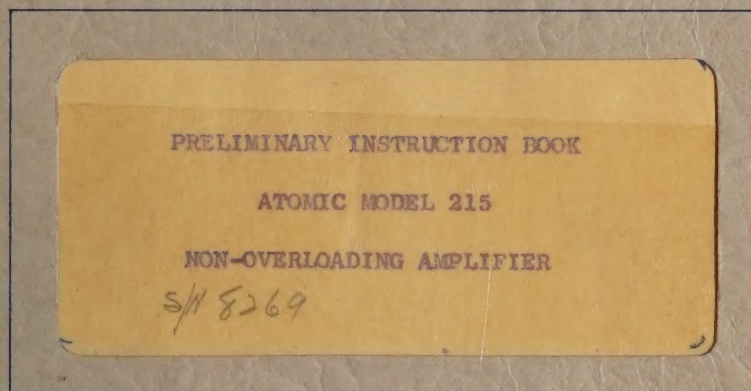


INSTRUCTION MANUAL



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PRELIMINARY INSTRUCTION BOOK

ATOMIC MODEL 215

NON-OVERLOADING AMPLIFIER

S/N 8269

BAIRD ASSOCIATES-ATOMIC INSTRUMENT CO.
Engineering-ATOMIC

Engineering-ATOMIC

PRELIMINARY INSTRUCTION BOOK

ATOMIC Model 215

Non-overloading Amplifier

- 1.1 General description: The Model 215 amplifier is a linear pulse amplifier, capable of fast recovery after severe overload (as specified on page 3). It amplifies faithfully small pulses in the presence of much larger frequent overload pulses. This feature makes the Model 215 amplifier particularly useful for pulse height analysis of X-rays in the presence of high energy gamma rays.
- 1.2 Non-overloading amplifier loops: The three amplifier loops are essentially similar, incorporating some of the design features of both the "Oak Ridge-Fairstein" and the "Brookhaven-Chase" design. Special attention is paid to the output loop to preserve linearity through the "bootstrap" technique. Feedback is applied in all cases to the cathode of the first stage.
- 1.3 Specifications:
- 1) Total current from 115V mains: 1.8 amps
 - 2) Physical dimensions: 8 3/4" standard rack mount
extending 1 1/4 inches behind panel
 - 3) Weight: 45 lbs.
 - 4) Finish: Gray lacquer, white and black engraving
Steel chassis cadmium plated with iridite dip
 - 5) Controls: All controls are mounted on the front panel; they consist of:
 - a) Power switch
 - b) Coarse gain: A six position rotary switch indicating relative amplitudes. Steps are: 64, 32, 16, 8, 4, 2. Temperature stable, precision resistors.

- c) Fine gain: A wire wound, temperature stable, continuous control, varying the relative output from 100% to about 37%.
- d) Pulse Height Selector: sets the threshold of the integral discriminator. Range (0-100V) referred to the amplifier output.
- 6) External Connectors: all mounted in the rear
 - a) Input BNC
 - b) Pre-amplifier: AN 3102-16S-1S
(Mounting of this connector is optional, either on the rear panel or the third subchassis)
 - c) High Out: Cathode of V110, max. output 110V, pos. polarity, pulse shape as sketched in table 1, impedance 300 ohms (or by-passing RL70 output impedance 100 ohms)
 - d) Low Out: Fixed ratio of High Out (1/30), output impedance 300 ohms.
 - e) PHS Out: Output from pulse height discriminator, 60V neg.,
0.7 usec impedance 3,300 Ohms.
- 7) Gain: Max. about 6,400
Min. about 100
- 8) Linearity: 0.5%
- 9) Rise Time: 0.2 usec
- 10) Noise: White noise at max, gain 1 volt, rms, 60 cps ripple at max.
gain 0.5 volts, rms.
- 11) Gain stability: A change of line voltage from 95 volts to 130 volts effects the gain by less than 0.5%. Temperature stable

10-4 110V
10-5 100V
10-7 100V
10-6 100V

resistors are employed for critical signal coupling.

- 12) Overload test: For large signals the design of the amplifier provides fivefold limiting. The recovery time is proportional to the logarithm of the input pulse height and is about 40 μsec for 1000 times overload. (1000 time overload refers to an input signal 1000 times larger than one which gives full output). Owing to these features, the amplifier does not introduce any base line distortion after recovery, even under severe overload condition.
- 13) Reliability: As a rule derating of tubes (half emission and half power) and derating of resistors was applied.

2.1 Principle of Operation

The Model 215 amplifier accomplishes optimum pulse shaping through two "differentiations". The input signal which should have a decay time constant equal or larger than 200 μsec is "differentiated" through the input RC network (time constant 2.4 μsec). This reduces the pile up considerably and permits the use of smaller low frequency coupling time constants.

The coarse gain control is a precision resistor attenuator at the input of V101. After an amplification of twenty-eight through the first feedback amplifier, the signal passes the fine gain control. The second stage has a gain of twenty-two as referred to the delay line. The adder circuit (V105) receives signals of opposite polarity: one from the cathode of V104B and the other one delayed one μsec , so that the output is a "differentiated" signal as depicted in Graph 1. The fourth stage is again a feedback amplifier of a gain of fifty and

employs positive feedback to insure large linear outputs. Max. positive signal excursion is limited to 110 volts by means of a double diode clamp V107.

The output stage is basically a feedback amplifier; the output, however, is taken from the cathode of the first tube, V110, making this stage in effect an elaborate cathode follower. The purpose of this stage is to decouple the output load from the sensitive feedback cathode of V109 and to supply enough current for external loads up to 500 ohms (50 ma peak current).

2.2 Non-overloading Features

Overloading in the usual sense of the word refers to effects of non-linear operation caused by large input signals. In particular the charging of grid coupling capacitors, owing to grid current, introduces disturbing after effects. A non-overloading amplifier design introduces non-linearities (limiting) deliberately, in such a way, that the transition to the normal, linear mode of operation can occur immediately after the overload signal ceases.

Three types of non-overload techniques are used:

- a) Limiting of max. input (V105, V106A)
- b) D.C. coupling in order to avoid charging of coupling capacitors (V101B, V103B)
- c) Use of small grid resistors so that grid current operation does not change input time constant appreciably (V106A, V108)

2.3 Detailed Description of Operation

a) First stage:

The negative input signal is amplified through V101A and appears as positive signal at the grid of V101B. V101B and V102A are connected as difference amplifier, the grid of V102A being tied to the grid of V101B through a large time constant (i.e. R115 and C101). If the positive input signal at the grid of V101B is small, the difference amplifier can operate with a low effective cathode impedance (namely the cathode input impedance of V102A). If the signal becomes larger, all current passes through V101B, V102A being cut-off, and consequently the effective cathode impedance is now R114, which means that the gain of V101B is reduced by a factor of ten. For large signals V101B will draw grid-current. Since there is no coupling capacitor in the grid circuit, V101B will return to its quiescent operating point as soon as the large signal ceases. With normal, negative input signals the plate of V101B will make negative excursions; therefore, conventional RC coupling to the cathode follower stage ^(V102B) V102A is used.

High frequency negative feedback is applied from the cathode of V102B to the cathode of V101A. There is, however, a second feedback loop: from the cathode V101B (and V102A) via R113 and R107 to the grid of V101A. A large time constant (R112 and C101) makes this feedback effective only for the quiescent current conditions of V101A and the difference amplifier. In this way the gain characteristics of the first stage is greatly stabilized.

b) The second stage is very similar to the first one, except that V104B has as plate load, the delay line and its matching resistor R132.

c) Pulse shaping circuit: The grids of V105 are biased to about 14 V in order to secure cathode degeneration. One grid (pin 2) receives a fraction of the negative output of the second stage, whereas the other grid (pin 7) receives the delayed signal of equal magnitude. Adding these two signals by means of a common plate current results in a positive signal of about one μ sec duration, followed by a negative signal of exponential decay. Note that the effective plate load is 4.7K in parallel with 5.1K, so that the adder circuit has a gain of one.

d) The fourth stage is a feedback amplifier with an over-all gain of fifty. The plate load of V104 is in parallel with R151 (for reasons of grid current operation R151 is only 5K). The plate of V104 is "bootstrapped" through C123. Since the max. excursion of the plate of V104 is limited by V107, no danger of grid current exists for V104. The large choke L103 keeps the current drain from the E^+ supply essentially constant and reduces the current requirement on V109.

e) The fifth stage is the output feedback amplifier with inductances at such places where current economy is possible and advantageous. The output is taken from the cathode of V110. Power for external loads is available from the magnetic field of L104 and through V110 (since the current through L109 stays constant). *Not incorporated*

3.1 Pulse Height Discriminator

The output pulses of the amplifier are applied ^{to} the difference amplifier comprising V117 and V118. The grid of V118 is held fixed at 100V, whereas the d.c. grid bias of V117 is varied by means of a

precision helical potentiometer R157. A positive signal overriding the bias of V117 will give a negative output through C138.

V119 and V120 are connected as Schmitt Circuit. V119 is normally conducting so that a sharp break-away is achieved. The positive pulse through C142 triggers the output pentode V121, which is normally cut-off by means of a large cathode resistor. Since the coupling time constant (C142 and R203) is short, the output pulse from the discriminator is fast negative pulse.

This circuit is nearly identical with the AID amplifier discriminator of Bell and Jordan.

4.1 Power Supply

The raw E^+ of 350V at the output of the filter section C131, L101 and C132 is applied to the plates of the series regulator tube V113. V114 in conjunction with V115 provides electronic regulation. The output voltage at full load (160 ma) is 270V, the rms ripple is 20 mv.

Two selenium rectifiers CR101 and CR102, a double AC filter (F174, C133, and R175, C134) and a cold cathode regulator tube (V116) furnish the negative reference voltage for bias.

VOLTAGE & RESISTANCE MEASUREMENTS

VACU TYPE	TUBE PIN NUMBER								
	1	2	3	4	5	6	7	8	9
V101	75	72	220	24K	0	1.9	3.6	100	72
6AV6	15K	27K	20K	HT.	0	500	220K	82K	27K
V102	75	72	220	23K	0	1.7	10	250	250
6AV8	13K	220K	0	HT.	0	120	50K	0	0
V103	75	72	220	6.3AC	0	1.6	2.5	100	72
6AV8	15K	27K	20K	HT.	0	100K	100K	82K	27K
V104	75	72	240	6.3AC	0	24	18	232	232
6AV8	15K	220K	0	HT.	0	1.8K	180K	1.2K	1.2K
V105	100	15	72	6.3AC	0	1.5	15	16	0
6B2K	4.7K	230K	24K	HT.	0	4.7K	230K	24K	0
V106	12	12	12	6.3AC	0	1.0	0	35	122
6AV8	1	1	1	HT.	0	100K	51K	50K	50
V107	250 230	125	6.3AC	0	250 230	125	120		
6AL5	0	8.5K	1	0	1	1	8.5K		
V108	0	4.1	142	6.3AC	0	130	0	142	4.1
6CL6									
6107	0	4.5K	18K	HT.	0	8.5K	0	18K	4.5K
V109	24	12	250	6.3AC	0	250	24	250	12
6CL6									
6190	0	8.5K	0	HT.	0	0	0	0	8.5K

DATE	TIME	WIND	TEMP	HUMID	WIND	TEMP	HUMID	WIND	TEMP
10/1	10:00	10	20.0	100	0	18.5	71	200	0
10/2	10:00	10	10.0	10	0	10.0	10	0	0
10/3	10:00	10	20.0	100	0	10.0	10	0	0
10/4	10:00	10	10.0	10	0	10.0	10	0	0
10/5	10:00	10	10.0	10	0	10.0	10	0	0
10/6	10:00	10	10.0	10	0	10.0	10	0	0
10/7	10:00	10	10.0	10	0	10.0	10	0	0
10/8	10:00	10	10.0	10	0	10.0	10	0	0
10/9	10:00	10	10.0	10	0	10.0	10	0	0
10/10	10:00	10	10.0	10	0	10.0	10	0	0
10/11	10:00	10	10.0	10	0	10.0	10	0	0
10/12	10:00	10	10.0	10	0	10.0	10	0	0
10/13	10:00	10	10.0	10	0	10.0	10	0	0
10/14	10:00	10	10.0	10	0	10.0	10	0	0
10/15	10:00	10	10.0	10	0	10.0	10	0	0
10/16	10:00	10	10.0	10	0	10.0	10	0	0
10/17	10:00	10	10.0	10	0	10.0	10	0	0
10/18	10:00	10	10.0	10	0	10.0	10	0	0
10/19	10:00	10	10.0	10	0	10.0	10	0	0
10/20	10:00	10	10.0	10	0	10.0	10	0	0
10/21	10:00	10	10.0	10	0	10.0	10	0	0
10/22	10:00	10	10.0	10	0	10.0	10	0	0
10/23	10:00	10	10.0	10	0	10.0	10	0	0
10/24	10:00	10	10.0	10	0	10.0	10	0	0
10/25	10:00	10	10.0	10	0	10.0	10	0	0
10/26	10:00	10	10.0	10	0	10.0	10	0	0
10/27	10:00	10	10.0	10	0	10.0	10	0	0
10/28	10:00	10	10.0	10	0	10.0	10	0	0
10/29	10:00	10	10.0	10	0	10.0	10	0	0
10/30	10:00	10	10.0	10	0	10.0	10	0	0
10/31	10:00	10	10.0	10	0	10.0	10	0	0

UNIT 16: PRACTICE 3: MEASURING CAPACITANCE

C. No.	RESISTANCE READINGS								
	1	2	3	4	5	6	7	8	9
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K
1000	2.1K	2.2K	2.3K	2.4K	2.5K	2.6K	2.7K	2.8K	2.9K

NOTE: RESISTANCE READINGS OBTAINED WITH
 1000 OHM RANGE OF ANALOG METER
 CHARGE & DISCHARGE CAPACITOR WHILE
 MEASURING WITH OHMMETER.



OUTPUT DELAY LINE
STAGE

OUTPUT LASS STAGE 110V MAX

INPUT

INPUT

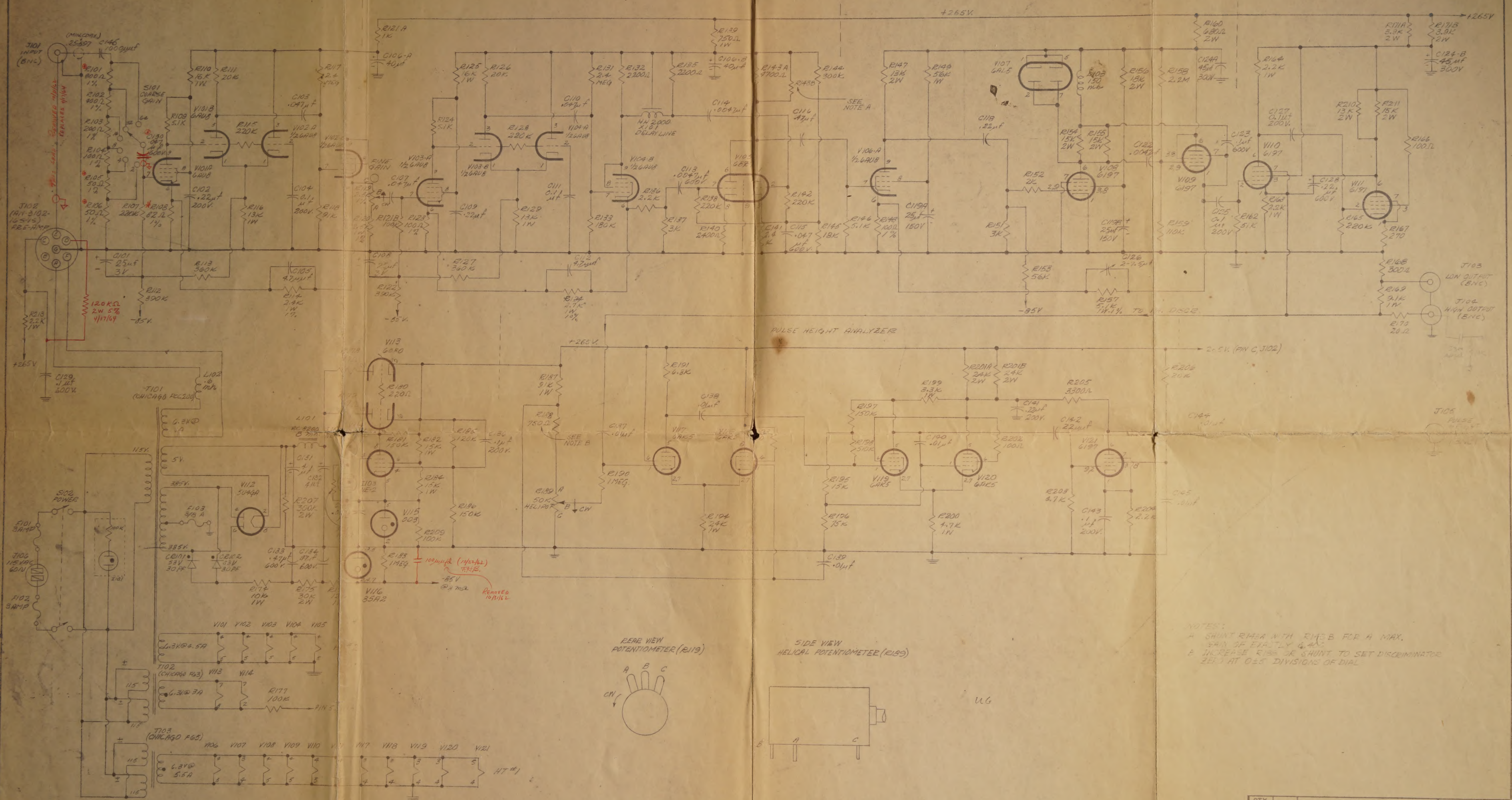
INPUT

FIRST AMPLIFIER SECTION

SECOND AMPLIFIER & DELAY STAGE

HIGH LEVEL AMPLIFIER

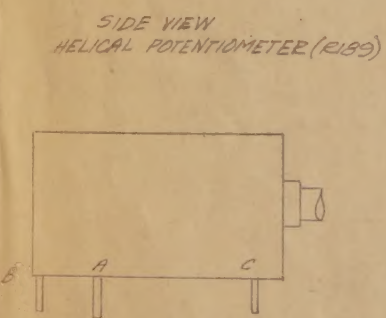
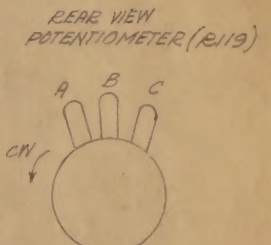
OUTPUT STAGE



REVISIONS

NO.	DESCRIPTION	DATE
1	REPLACED R108 WITH SERIES 50.2K 1/2W 1% RESISTOR	10/11/62
2	REPLACED R101 WITH 200K 1/2W 1% RES.	10/11/62
3	C103 REVERSED AND LEAD SOLDERED	10/11/62

* REPLACED R108 WITH SERIES 50.2K 1/2W 1% RESISTOR
 1/2W 1% RESISTORS 7548 1/2W 1%
 ② REPLACED R101 WITH 200K 1/2W 1% RES.
 ③ R103 + R106 WITH 51.1K 1/2W 1% RES.
 ④ C103 REVERSED AND LEAD SOLDERED



NOTES:
 A SHUNT R158A WITH R158B FOR A MAX. GAIN OF EXACTLY 4.40.
 B INCREASE R158 OR SHUNT TO SET DISCRIMINATOR ZERO AT 0.05 DIVISIONS OF DIAL

QTY.	DESCRIPTION	STOCK NO.	PT.
RELEASED: PROCUREMENT			
RELEASED: PROTOTYPE			
RELEASED: PILOT RUN			
RELEASED: FULL PRODUCTION			
UNLESS NOTED ALL RESISTORS ARE 1/2WATT AND ± 5%			
DR. M.D.M.	2-23-52	CK. VJ	APP. R.H. M.
SCHEMATIC NON-OVERLOADING LINEAR AMPLIFIER MODEL 215			
ATOMIC INSTRUMENT COMPANY			REV
D-215-1			SEP 17 1956

6679
6718
2671
2681

6" $\pi \frac{D^2}{4} \times 2$

14
22 1/2
23 1/2
24 1/2
25 1/2
26 1/2
27 1/2
28 1/2
29 1/2
30 1/2



Symbol of leadership
in scientific
instrumentation